COMPLEX MOTION PROBLEMS – PART DEUX

1. Stopping distances for cars are important for traffic safety. Let's assume that a car is travelling at 100 km/h on dry pavement. Under these conditions, this car can decelerate at 6.0 m/s^2 to a complete stop. The driver's reaction time (the time that it takes him to realize that he needs to fully apply the brakes) is 0.50 s.
   a. What distance does the car travel during the reaction time? We can safely assume uniform motion during this time interval. *[13.9 m]*
   b. What distance does the car travel during the braking period? *[64.3 m]*
   c. What total distance would thus be required between the car and another object in front of the car in order for no collision to occur? *[78.2 m or ~75% of the length of a football field]*

2. The same vehicle is travelling on the same road surface except that this time the pavement is wet. The wet pavement reduces friction and thus the acceleration can become 1/3rd of what it was in question 1. What stopping distance is required? This time assume that the reaction time was 0.40 s. *[204 m]*

3. A truck, travelling at 80 km/h, is 100 m in front of me. I am travelling at 90 km/h. How long will it take me to overtake the car, assuming that we both maintain a constant velocity? How far will I travel? *[35.7 s]*
   [892.5 m]

4. A woman driving her car at 50 km/h approaches an intersection when the traffic light turns yellow. She knows that the yellow light lasts only 2.5 s before turning to red and she is 35 m away from the near side of the intersection. If her reaction time to step on the brakes is 0.3 s and her car can decelerate at 6.0 m/s^2, should she try to stop? *[yes, with 14 m to spare]*

5. Same question as above with the following modifications. Instead of putting her foot on the brake, she decides to make a run to beat the red light. The intersection is 12 m wide and her car takes 7.0 seconds to accelerate from 50 km/h to 70 km/h. If her reaction time is the same, can she beat the red light? *[no]*

6. The speed of sound in air is uniform at a given temperature. Suppose you fire a bullet (1600 m/s) in a shooting gallery and hear the gong on the target ring 0.731 s *after the bullet is fired.* We will assume that the bullet maintains this velocity from the moment it is fired to the moment it strikes the target ring. How far away is the target ring from the gun if the speed of sound is 340 m/s? *[205 m]*
   Hint: (a) The bullet spends a 'portion' of its time travelling towards the target ring and the sound spends the remainder of the 'time' travelling back towards the listener.
   (b) The distance the bullet travels towards the target ring is the same as the distance the sound travels back towards the listener.

7. A driver travelling at 60 km/h sees the proverbial chicken cross the road to get to the other side! Why did it have to cross the road, he thinks! He slams on the brakes and, accelerating at -7.0 m/s^2, stops just in time 23.3 m down the road. What was the driver's reaction time? *[0.21 s]*

8. Two trains, heading straight for each other on the same track are 250 m apart when their engineers see each other and hit the brakes. The Express, heading west at 96 km/h, slows down at 4 m/s^2 while the eastbound Flyer, travelling at 110 km/h, slows down at 3 m/s^2. Will they collide? *[nope]*

9. Having taken a nap under a tree only 20 m from the finish line, Rabbit wakes up to find Turtle 19.5 m beyond him, grinding along at 0.25 m/s. If the bewildered wabbit can accelerate at 9.0 m/s^2 up to a top speed of 18 m/s and sustain that speed, will he win the race? *[no]*